REMARKS

This response is offered in reply to the Office Action of October 31, 1994.

Claim 21 is rejected under 35 USC 112, fourth paragraph as not further limiting the scope of the claim from which it depends. Claim 21 has been cancelled since it was incorporated into claim 20 by the previously-filed response.

Claims 23 and 24 are rejected under 35 USC 112, second paragraph as indefinite. Applicants have amended these claims in a manner to close the claims to other alloy components. Reconsideration of the rejection is requested.

Claims 1, 4, 6, 9, 12, 16, 19, 20, 21 and 23-26 are rejected under 35 USC 102(b) in view of the Ferrie're et al. reference (US 1 437 641). The Examiner refers to lines 79-82 of the cited patent and indicates that the composition range given inherently includes at least one composition with the melting range and phase distribution claimed in claims 6, 12, 20, and 21. The Examiner also indicates that claiming the solder as an "electrical solder" is merely a statement of the intended use of the solder, and, as such, is given little or no patentable weight.

Applicants disagree with this rejection. In particular, the characterization of Applicants' solder as electrical conductor solder is not merely a recitation of intended use but rather differentiates it from other solders such as plumbing solders, that have differently tailored compostions, microstructures and properties; for example, having a wide liquid plus solid mushy working range of at least 15 degrees C and up to about 25 degrees C for plumbing solders to be troweled into a wide gapped plumbing joint. The Examiner will appreciate that solders are sold as electrical conductor solders, plumbing solders, etc. so that the appropriate solder compositions and properties can be selected. Thus, the terminology electrical conductor solder differentiates Applicants' solder from plumbing and other solders and should be considered from a patentability standpoint.

The Ferrie're et al. reference does not disclose a Pb-free electrical conductor solder as recited in amended claim 1. For example, at column 2, lines 79-82 referred to by the Examiner, the Ferrie're et al. reference discloses an aluminum cooking vessel solder consisting of 85-95% Sn, 0.5-9.5% Zn, 0.5-4.5% Ag, and 0.5-4.5% Cu. At column 2, lines 69-77, the Ferrie're et al. reference

discloses a low Sn solder specifically for electric conductors generally consisting of 86% Sn, 0.5-13.5% Cu, and 0.5-13.5% Ag. This solder is tailored to aluminum electrical conductor soldering. The Ferrie're et al. patent discloses other specific solders tailored for aluminum cooking vessels, tins or cans, etc. in column 2 and recognizes and teaches that different solder compositions are used to this end for different aluminum components to be soldered.

In contrast, Applicants' claim 1 relates to an electrical conductor solder having improved wettability especially useful for soldering Cu, Ag, and Au electrical conductor materials. Applicants' solder consists essentially of about 3.5 to about 7.7 weight % Ag, about 1.0 to about 4.0 weight % Cu and the balance essentially Sn wherein Sn is present in an amount of at least about 89 weight % Sn to promote formation of intermetallic compounds that improve solder wettability on the electrical conductor. Applicants' claimed solder overcomes any problem associated with solder wettability on an electrical conductor. Solder wettability is improved by formation of intermetallic compounds as illustrated in the technical article (copy enclosed) entitled "Wetting of Solid-Metal Surfaces by Molten Metals", by R. J. Klein-Wassinf in J. Institute of Metals, 95, (1967), pp. 38-43.

The low Sn electrical conductor solders specifically disclosed by Ferrie're et al. for aluminum conductors are directed away from Applicants' relatively high Sn ternary eutectic solder composition of claim 1 having at least about 89 weight % Sn to promote formation of intermetallic compounds for improved solder wettability on an electrical conductor, such as Cu, Ag, and Au. The specific teachings of the Ferrie're et al. reference clearly lead one skilled in the art away from selecting just any composition from among a very broad solder composition range for soldering a specific aluminum component.

Applicants do not believe the Examiner can legitmately ignore the express teachings of the Ferrie're et al. patent to provide specific solder compositions for specific aluminum components such as cooking vessels, electrical conductors, etc. and simply cite the broad solder composition range set forth for aluminum cooking vessels as a basis for rejecting Applicants' claims to electrical conductor solder. The express teachngs of the Ferrie're et al patent militate against this. The Ferrie're et al. patent discloses a specific, relatively low Sn electrical conductor solder that does not anticipate Applicants' electrical solder and instead teaches away therefrom.

Reconsideration of the rejection of amended claim 1 and claim 4

depending thereon is requested.

The rejection of claims 6, 12, 20, 21, and 23 on the basis that the composition range given in the Ferrie're et al. patent inherently includes at least one composition with the melting range and phase distribution claimed in claims 6, 12, 20, and 21 is believed to be patently in error.

In particular, for example, claim 6 recites a Pb-free electrical conductor solder involving a <u>heretofore unknown</u> ternary eutectic composition consisting of about 93.6 weight % Sn-about 4.7 weight % Ag-about 1.7 weight % Cu having a eutectic melting temperature of about 217 degrees C and variants of the ternary eutectic composition wherein the relative concentrations of Sn, Ag, Cu deviate from the ternary eutectic composition to provide a controlled liquid plus solid mushy temperature range with a liquidus temperature not exceeding 15 degrees C above the eutectic melting temperature. The same is true of claims 12 and 20 directed to a solder joint and soldering process, respectively.

The Ferrie're et al. reference discloses vastly different binary, ternary, and quaternary solder alloy compositions for soldering different aluminum components and nowhere recognizes or discloses firstly that a ternary eutectic composition of about 93.6 weight % Sn-about 4.7 weight % Ag-about 1.7 weight % Cu exists, and secondly that the ternary eutectic composition exhibits a unique invariant melting point of about 217 degrees C that renders it highly suitable as a preferred Pb-free electrical conductor solder.

The Examiner's statement that Ferrie're et al.'s compositional range would include at least one composition with the melting range and phase distribution of the rejected claims ignores the lack of disclosure in the reference firstly of the existence of ternary eutectic composition and secondly the utterly vast combination of different alloying elements set forth in the reference that are possible without any teaching as to which particular alloying elements to use in combination and in what relative amounts to achieve Applicants' solder having the recited melting temperature range.

Moreover, the Examiner's statement also flies in the face of the results of studies of numerous alloy phase systems that have found ternary eutectic reactions to be uncommon. For example, the previous archival studies on the Sn-Ag-cu system found that Class II ternary two-phase (L + S = S1 + S2) solidification reaction ocurred in the approximate composition range of Applicants' discovery of the <u>true</u> ternary eutectic (L = S + S1 + S2)

solidification reaction. Unexpectedly, Applicants have discovered a previously unknown ternary eutectic for the Sn-Ag-Cu system and set forth in claims 6, 12, 20, and 23 for a solder, solder joint, and soldering process embodying the ternary eutectic and variants thereof. The existence of Applciants' claimed ternary eutectic composition was not heretofore known and is not disclosed or predicted by the Ferrie're et al. patent which, as mentioned, involves vastly different binary, ternary, and quaternary solder alloy compositions. That there is a broad range for the cooking vessel solder of Ferrie're et al. does not disclose to or place in the posession of one skilled in the art the unexpected ternary eutectic composition and its melting temperature as well as phase components discovered by Applicants to constitute a Pb-free electrical conductor solder.

The Examiner's basis for rejecting claims 6, 12, 20, and 23 would prevent patenting of alloys having compositions residing within broader disclosed reference ranges but unrecognized by the art to that time. This basis is not in accordance with accepted patent law principles and fails to recognize the difficulty and unpredictability in the metallurgical art of making generalizations from one alloy composition and applying to another alloy composition. As mentioned, Applicants Pb-free electrical conductor solder involves a <u>heretofore unknown and thus unexpected</u> ternary eutectic composition consisting of about 93.6 weight % Sn-about 4.7 weight % Ag-about 1.7 weight % Cu having a eutectic melting temperature of about 217 degrees C that renders it a preferred Pb-free electrical conductor solder.

One skilled in the art looking at the Ferrie're et al. reference is not apprised of Applicants' solder, solder joint and solder process set forth in claims 6, 12, 20, and 23. But for Applicants' discovery, a solder based on the recited ternary eutectic composition having the melting range and microstructure recited would be unknown and not available to those skilled in the art in need of a Pb-free electrical conductor solder.

Reconsideration of the rejection of amended claims 6, 12, 20 and 23 as anticipated by Ferrie're et al. reference is requested. Claims 9 and 16 depending from claim 6 and 12, respectively, are believed patentable on the same basis as set forth for the claim from which they depend.

Claims 23-26 have been amended to the closed form and are believed allowable over the cited Ferrie're et al. for the reasons set forth hereabove. Applicants note that the cooking vessel solder of the Ferrie're et al. patent requires Zn to be present no doubt to attack the well known alumina surface film on the aluminum vessel

to be soldered.

Reconsideration of the rejection of claims 1, 4, 6, 9, 12, 16, 19, 20, and 23-26 under 35 USC 102(b) in view of the Ferrie're et al. reference is requested.

Claims 18 and 22 are rejected under 35 USC 103 in view of the aforementioned Ferrie're et al. patent. Claims 18 and 22 relate to a solder joint and soldering process, respectively, and are believed allowable in view of the deficiencies of the Ferrie're et al. patent discussed hereabove. The cited patent does not suggest a solder joint and soldering process for copper electrical conductors as set forth in claims 18 and 22. The cited patent is directed at soldering aluminum and its alloys and, as discussed hereabove, employs an electrical solder having relatively low Sn as compared to Applicants' solder recited in claims 18 and 22. Reconsideration of the rejection of claims 18 and 22 is requested.

Claims 6, 11, 12, 14, 19, 20, 21, and 23-26 are rejected under 35 USC 102(b) in view of the Mizuhara patent.

Applicants have amended the claims to better explain the solder of the invention. In particular, claims 12 and 20 now recite, in combination with the other features, that the ternary composition and variants thereof are free of Ti, V, and Zr. In contrast, the Mizuhara reference discloses a ductile brazing alloy having 35-95% Sn, 0.5-70% Ag, 0.5-20% Cu, 0.1-4% Ti and/or V and/or Zr, 0-5% Ni, and 0-2% Cr for bonding to ceramic under vacuum conditions. To this end, the reference requires the presence of one or more the reactive elements Ti, V, and Zr in the alloy that are reactive with the ceramic surface to be soldered. The Mizuhara patent must be conducted under vacuum and not ambient air or inert gas cover which can include oxygen; e.g. see column 1, lines 41-45. In contrast, Applicants' claimed soldering process can be practiced in ambient air or inert cover gas even if it includes oxygen.

Claims 11, 19, and 23-26 are closed claims that preclude such alloying elements as Ti, V, and Zr that are required in the Mizuhara patent in order to solder ceramic. They are believed allowable over the cited Mizuhara patent.

The Mizuhara reference fails utterly to disclose a Pb-free electrical conductor solder, solder joint and soldering process wherein a <u>heretofore unknown</u> ternary eutectic composition consisting essentially of about 93.6 weight % Sn-about 4.7 weight

% Ag-about 1.7 weight % Cu having a eutectic melting temperature of about 217 degrees C is employed and variants of the ternary eutectic composition wherein the relative concentrations of Sn, Ag, Cu deviate from the ternary eutectic composition to provide a controlled mushy temperature range with a liquidus temperature not exceeding 15 degrees C above the eutectic melting temperature.

The Mizuhara reference nowhere recognizes or discloses firstly that a ternary eutectic composition of about 93.6 weight % Sn-about 4.7 weight % Ag-about 1.7 weight % Cu exists, and secondly that the ternary eutectic composition exhibits a unique invariant melting point of about 217 degrees C that renders it a highly suitable Pb-free electrical conductor solder. As mentioned, the Mizuhara reference requires the presence of one or more reactive elements Ti, V and Zr. Brazing is conducted under vacuum conditions so as not to deplete prematurely the reactive alloy component of the braze needed to attack the oxide surface of a ceramic oxide. The compositional ranges of the reference are so broad as to provide no guidance as to Applicants' claimed ternary eutectic composition and variants thereof recited in the claims. Moreover, the Mizuhara reference discloses the possible inclusion of Ni in the alloy composition. Applicants' solder is free of Ni as set forth on page 10 of the specification.

The Examiner ignores the lack of disclosure in the reference firstly of the ternary eutectic composition and secondly the large combination of different alloying elements set forth in the reference that are possible without any teaching as to which particular alloying elements to use in combination and in what relative amounts in the overly broad ranges set forth to achieve Applicants' solder having recited melting temperature range.

The Examiner no doubt will appreciate that Applicants' claimed solder based on the heretofore unknown ternary eutectic composition free of reactive elements and having the microstructure comprising beta Sn phase and both Cu-Sn bearing and Ag-Sn bearing intermetallic compounds dispersed in the matrix and imparting strength thereto is not remotely disclosed in the Mizuhara reference. One skilled in the art looking at the Mizuhara reference is not apprised of Applicants' solder, solder joint and solder process set forth in Applicants' pending claims. But for Applicants' discovery, a solder based on the recited ternary eutectic composition having the melting range and microstructure recited would be unknown and not available to those skilled in the art in need of a Pb-free solder for joining <u>metallic</u> conductors.

Reconsideration of the rejection of pending amended claims 6, 11, 12, 14, 19, 20, and 23-26 as anticipated by the Mizuhara reference

is requested. Depending Claims 14 is believed patentable on the same basis as set forth for claim 13 from which it depends.

Claims 2, 3, 8, 14 and 15 are rejected under 35 USC 103 in view of the aforementioned Ferrie're et al. reference taken with the Naton reference (US 4 879 096).

The deficiencies of the Ferrie're et al. reference are discussed above. Applicant fails to see how the Naton reference makes up for the deficiencies of the Ferrie're et al. reference with respect to Applicants' Bi level. Although the Naton reference involves a Sn-Ag-Cu-Bi alloy, the concentrations of the alloying elements of the references are so different from one another as not to be properly combinable. For example, the Naton reference excludes zinc and cadmium from the alloy while the Ferrie're et al. reference requires zinc for the cooking vessel solder. Morever, the ranges of alloying elements of the Ferrie're et al. reference are so varied and different from those of Naton reference as to lead away from any combination of the references, especially by the Examiner's picking and choosing of one element from the Naton reference for use in the complex and varied alloys of the Ferrie're et al. reference. The Naton reference starts with a Sn-Cu-Bi alloy solder and adds a small amount of Ag less than 3 weight % (typcially only 0.1 and 0.2 weight % Ag) for enhancing mechanical properties such as shear strength. Moreover, the Naton reference involves a solder having a working range (mushy zone) of up to 35-45 degrees F above the solidus in contrast to the mushy zone not exceeding 15 degrees C set forth in some of Applicants' claims.

Applicants request reconsideration of the rejection of clams 2, 3, 8, 14 and 15.

Claims 2, 3, 8, and 15 are rejected under 35 USC 103 in view of the aforementioned Mizuhara reference taken with the aforementioned Naton reference.

The deficiencies of the Mizuhara reference are discussed above. Applicant fails to see how the Naton reference makes up for the deficiencies of the Mizuhara reference with respect to Applicants' Bi level. Although the Naton reference involves a Sn-Ag-Cu-Bi alloy, the concentrations of the alloying elements of the references are so different from one another as not to be properly combinable. For example, the Naton reference makes no disclosure of a reactive elment such as Ti, V, and Zr present in the Mizuhara reference. Morever, the ranges of alloying elements of the Mizuhara reference are so varied and different from those of Naton reference as to lead away from any combination of the references, especially

by the Examiner's picking and choosing of one element from the Naton reference for use in the complex and varied alloys of the Mizuhara reference.

Applicants request reconsideration of the rejection of claims 2, 3, 8, and 15.

Entry of this amendement and allowance of the pending claims is requested.

Respectfully submitted,

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CERTIFICATE OF MAILING

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